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TREE DEFECTS AND STAND CONDITIONS ON THE HACKER CREEK EXPERIMENTAL AREA MORGAN-MONROE STATE FOREST INDIANA*

By

Richard D. Lane, Field Assistant
and
John G. Kuenzel, Assistant Silviculturist

Studies have been made on several of the recently acquired State and Federal forests of the central hardwood region to determine the character of the stands and the extent and principal causes of tree defect. Knowledge of these factors is needed in formulating silvicultural recommendations for specific areas and in deciding upon region-wide cultural policies. Such a study was made in 1937 on the 160-acre Hacker Creek Experimental Area, on the Morgan-Monroe State Forest, in southern Indiana.

This experimental area lies just south of the limit of glaciation. It presents a complexity of site conditions graduating from the narrow, damp flood plains of Hacker Creek to exposed south slopes and ridge tops. Logging operations during the period 1890-1900 and cuttings at irregular intervals thereafter removed from it all merchantable trees suitable for lumber and ties. The flood plains and ridge tops were under cultivation as late as 1925, and are now occupied by native weeds, grasses, and shrubs.

A randomized 5-percent strip cruise was made. Every tenth tree more than 2.5 inches in d.b.h. on the strips was examined for defect, regardless of species or condition; this gave a 0.5-percent random sample of the defect in the stand. A count of the reproduction was made on a 100-foot-square quadrat for each chain of line cruised.

Stand Conditions

The cruise revealed stand conditions as follows:

1. The stand contains 170 trees 2.5 inches and more in d.b.h. per acre, averaging 6.5 inches in d.b.h., 40.6 feet in height, and 37 years in age and having, on the average, an annual diameter growth per tree of 0.2 inch.

2. The white oak-black oak-red oak type occupies 50 percent of the area.

3. Approximately 20 percent of the area is grassland.

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* The field work of this study was done in cooperation with the Indiana Department of Conservation, Division of Forestry, and with C.C.C. Camp S-52, Martinsville, Indiana.

4. Reproduction less than 2.5 inches in diameter averaged 972 stems per acre. About 50 percent of the reproduction was sassafras, 20 percent oaks and hickories, and the remainder aspen, maple, and other hardwoods.

5. Approximately 80 percent of the reproduction was less than 0.6 inch in diameter and only 4 percent was more than 1.6 inches in diameter.

A summary of the condition of the overstory by species group and diameter class, and of its growth, is given in table 1.

Table 1.--Summary of stand conditions and growth

Species group[1] and diameter class[2] (inches)	Av. trees per acre	Av. height	Av. d.b.h.	Av. age	Av. annual diameter increment
	Number	Feet	Inches	Years	Inches
White oaks					
Saplings	16	25	3.1	25	0.12
Small poles	20	39	6.0	31	0.22
Large poles	10	48	9.0	50	0.20
Merchantable	10	49	11.2	50	0.18
Black oaks					
Saplings	12	28	3.0	24	0.12
Small poles	16	39	5.4	31	0.20
Large poles	8	54	8.5	47	0.22
Merchantable	9	58	11.8	42	0.30
Shagbark hickory					
Saplings	5	25	3.1	28	0.12
Small poles	5	33	5.0	28	0.22
Large poles	1	62	8.3	52	0.14
Merchantable	-	-	-	-	-
Other commercial species					
Saplings	18	56	3.1	30	0.12
Small poles	24	40	4.8	30	0.18
Large poles	7	57	9.0	61	0.18
Merchantable	9	61	12.9	73	0.14

1/ White oaks = white oak and chestnut oak.
Black oaks = red oak, scarlet oak, and black oak.
Other commercial species = aspen, beech, black walnut, yellow poplar, pignut hickory, mockernut hickory, black gum, and maple.

2/ The breast-height diameter classification used here, that of Forest Service Region 9, is as follows: Saplings, 2.5-3.5 inches; small poles, 3.6-7.5 inches; large poles, 7.6-9.5 inches; and merchantable, more than 9.6 inches.

Tree Defect

The tree-defect study was made to determine the types of defect present in the overstory trees, their relative frequency, and their relation to the volume of sound timber present on the area. Measurements were taken to determine the extent of decay or volume loss resulting from fire scars, branch stubs, insect tunnels, and miscellaneous defects.

Although the information obtained represents only a small part of the Morgan-Monroe Forest, this part may be considered a fair sample of the whole, since the entire forest has had a practically uniform history.

Fire Damage. Of the 107 overstory trees examined, 46 percent had fire scars; 35 percent of the scarred trees had open wounds and 65 percent had closed wounds. Every one of the fire-scarred trees contained some decay. A summary of fire scarring in the overstory is given in table 2.

Table 2.--Fire scarring, by species group and nature of scar

Species group 1/	Tree basis	Total trees with fire scars	Trees with open scars	Trees with closed scars
	Number	Percent	Percent	Percent
White oaks	37	51.3	16.2	35.1
Black oaks	31	54.9	6.5	48.4
Shagbark hickory	11	9.0	-	9.0
Other commercial species	28	42.9	28.6	14.3
All species	107	45.8	15.0	30 8

1/ For composition of species groups, see table 1.

During the period 1898-1928, dates of the earliest and the most recent fires of which evidence was found, at least 24 separate fires had occurred. The evidence pointed to a definite cessation of fires after 1928, when organized protection was initiated.

Branch Stubs. Of the trees examined, 85 percent were found to have branch stubs, and when dissected about 55 percent showed decay associated with such stubs. No significant difference appeared among species in susceptibility to branch-stub decay.

Insect Injury. Half the trees examined had been injured by insects, and each of these trees, on the average, had two separate points of attack.

The insects found on the area and identified by the Bureau of Entomology and Plant Quarantine were of only three primary families. They were Cerambycidae (round-

headed borers), species Goes pulverulentus and G. pulcher; Cossidae (carpenter moths), species Prionoxystus macmurtei; and Tenebrionidae (darkling beetles), species Strongylium tenuicolle.

Volume Loss Percent. On the basis of 104 sample trees, 9.5 percent of the total volume was defective. Fire damage was responsible for 63 percent of the total defective volume. Insects were second in importance, with 11 percent; and decay entering through branch stubs accounted for 6 percent. The remaining 20 percent of the defective volume resulted from miscellaneous injuries.

The white oak and black oak groups showed the largest volume of defect, shagbark hickory the smallest.

The results of the study of defect are summarized in table 3.

Table 3.--Extent of defect, by species group and cause

Species group	Tree basis	Volume of av. tree	Total volume	Defective volume, by cause: Fire scar	Branch stub	Insects	Total 1/
	Number	Cu.ft.	Cu.ft.	Percent	Percent	Percent	Percent
White oaks	35	4.3	150.4	8.8	0.2	0.3	11.1
Black oaks	29	3.0	87.3	6.2	0.5	3.3	11.1
Shagbark hickory	12	1.1	13.2	0.0	0.1	0.1	5.3
Other commercial species	28	4.1	115.5	2.9	1.0	0.2	7.2
All species	104	3.2	366.4	6.0	0.5	0.9	9.5

1/ Including defects resulting not only from major causes but from butt rot, wind shake, frost crack, mechanical wounding, and other miscellaneous causes.

Visibility of Defects. Each sample tree was carefully examined before felling for evidence of defect, and volume loss associated with defects invisible before felling was recorded separately. The ratio of losses from the two types of defect was about 1:1. This indicates the difficulties encountered in marking upland hardwood stands for cultural operations and in determining cull deduction in stumpage sales.

Discussion

With the exception of the large number of insect injuries, the findings in regard to defect were in line with those of defect studies in hardwood stands elsewhere in the Central States region. Although 93 percent of the trees had one or more defects, the total defective volume was not high (9.5 percent). This is explained in part by the low average age of the stand.

Approximately half the trees examined were found to have been injured by fire; all the fire-damaged trees were defective, and about two-thirds of the total volume loss from defect was traceable to fire injury. These facts very clearly indicate the need of adequate fire protection if stands such as that examined are to produce high-quality materials.

Analysis of the data showed that about half the trees had decay traceable to branch stubs, but only 0.5 percent of the total volume loss was attributed to this type of defect. The ratio of fire scars to branch stubs was about 1:1, but the percentage losses traceable to these two factors showed a ratio of approximately 11:1.

In frequency of occurrence insect injury ranked first among the causes of defect, but in volume loss percent it ranked second. The ratio of fire-scar losses to insect losses was about 6:1.

The remaining 2.1 percent volume loss was traceable to a number of causes such as butt rot transmitted from the parent stump, climatic injuries, and mechanical wounding.

Adequate fire protection would eliminate from future stands much of the defect that has resulted from fires in the existing stands. Silvicultural practices that improve growth rates and release suppressed trees would tend to reduce losses from infection through branch stubs and from insect attack. Sanitation cuttings should be made to remove defective, poorly formed, and otherwise undesirable trees from the stands. In any cultural operation, careful consideration should be given to the trees to be left on the area. The trees retained should be sound, well-formed individuals, numerous enough to ensure straight, clear form and natural pruning.